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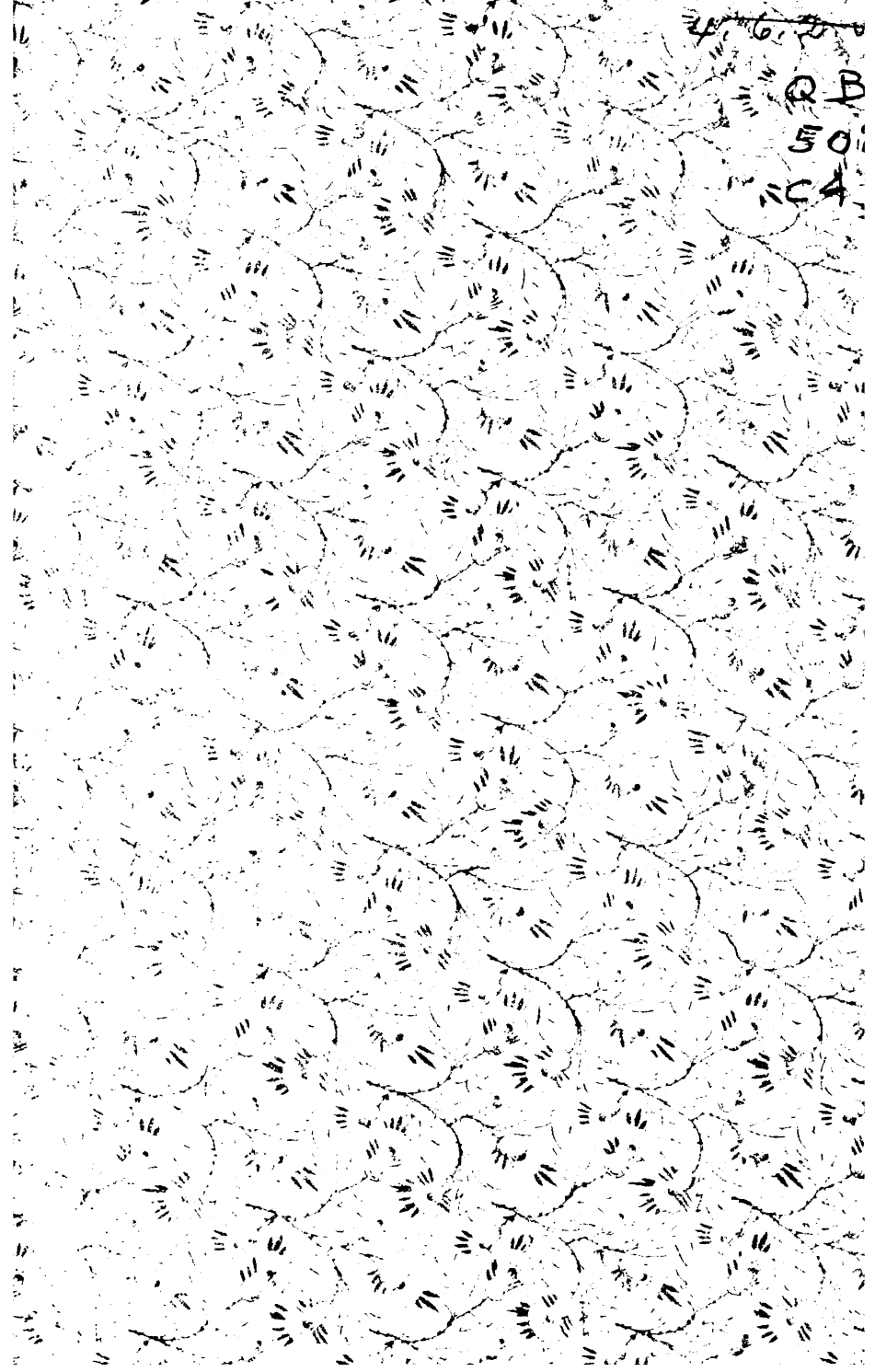
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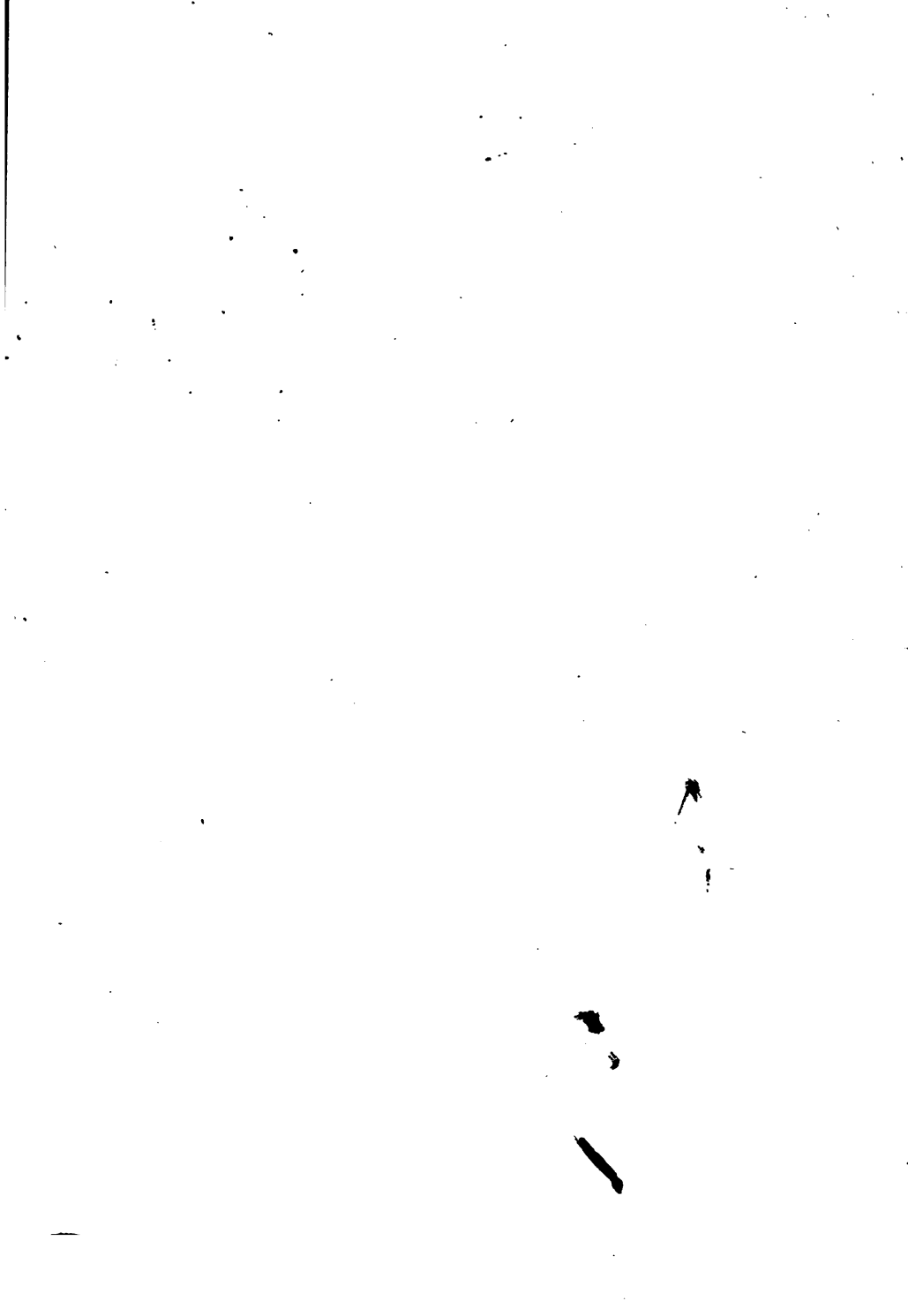
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CHAPIN'S
SYSTEM OF PLANET MOVEMENT

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THE SOLUTION OF REGISTERED ACCELERATION

THE MOON'S PATH AND ITS REGISTRATION ON THE ORBIT

AND

THE LOCATION OF THE CENTERS OF MOTION
OF PLANETS

BY

GEORGE LEANDER CHAPIN

CHICAGO, ILLINOIS

1894

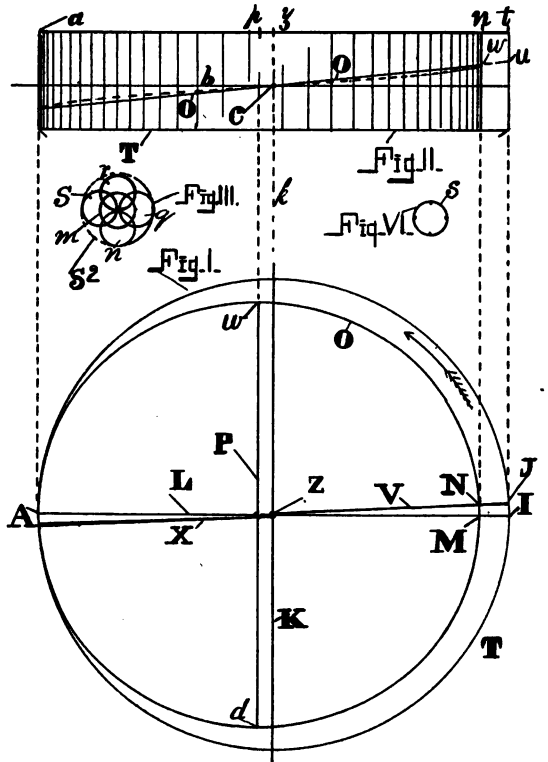
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June, 1894.

SOLUTION OF THE PROBLEM OF THE SUN'S REGISTERED ACCELER-
ATION ON THE ZODIAC, WHILE THE EARTH REGISTERS
EVEN DISTANCES IN EVEN TIMES ON THE BELT
MEASURE OF THE ELLIPSE.

0 Recd. 9-29-37
The material purpose of this work is, by proper drawings, specifications and deductions, forever to settle the question of what the motion of the earth is round the sun. I have emphatically denied the truth of Kepler's law of equal areas and the whole Newtonian system as to one planet having, by positive force, such as gravity, the power to accelerate or retard the motion of any planet. Being the only individual of record who has traced the spiral paths of planets round the moving sun, find that spiral paths cannot be correctly traced, under any law, round the sun, when acceleration on the orbit is made an element. But such paths coincide with the uniform velocity of the planet on its orbit, and are self evident facts, from the sun's motion in space, the orbits being cross or diagonal sections of the spiral paths.

That the earth is made to appear as having an accelerated angular motion of $61m. 9.9s.$ at perihelion on the zodiac, and an angular motion of $57m. 11.5s.$ at aphelion in one mean day of 24 hours is true, the mean being $59m. 8.33s.$ O, Fig. 1, represents the orbit of the earth; L, the major axis, and $w P d$, the minor axis; Z is the focus in which the sun, by the Copernicus system, is situated; A is aphelion, and M, perihelion; X and V are, respectively, the radii vector moving over the long and short segments of the orbit O. Now, as the earth is moving round the sun at Z, and its increment of angular velocity at A is known to be $57m. 11.5s.$, this sum is taken for the unit of motion on the orbit O, at A and zodiac

T, which, at aphelion, intersect. And as the purpose is to prove that the earth has a uniform velocity on the belt measure of the ellipse, we take the same unit, viz., $57m. 11.5s.$ for the earth's angular velocity at perihelion, M. Now, if our standpoint be the sun, and we could see the earth register on the great circle T, whose center is at Z, it would be seen



that the increment of $57m. 11.5s.$ between the points M N, perihelion has registered acceleration on the great circle T equal to the difference between I J and M N. This difference is $1.97m.$, and is the result of projecting the angular velocity of $57m. 11.5s.$ at M N onto the great circle, the zodiac at I J,

whose center divides the major axis of the ellipse in two unequal parts, the one part on the major axis, in round numbers being 92,963,000 miles, and the other part being 89,897,000 miles. John Herschel found this increment of acceleration on the zodiac, and accounted for its cause by the angular velocity being inversely as the distance. Having found nearly half the registered acceleration by the law of inversely as the distances, Herschel then assumes that all the registered acceleration which is less than $4m$.* is the result of another law, viz.: Inversely as the squares of the distances. That is, he proposes to combine the results of two laws, either of which in force subverts the other. Herschel was perplexed, and stated, "the cause of the sun's apparent motion was not forthcoming." He finally placed himself behind Kepler's law of equal areas, and left the cause for all the registered acceleration, more than $1.97m$. without any assigned cause. Mr. Herschel's faulty reasoning in the application of the two laws, the one inversely as the distances, and the other inversely as the squares, of the distances clearly shows that there were features in the problem which he could not comprehend. All others, down to the author, have put themselves in the same incomprehensible attitude.

The law governing the acceleration from I to J of $1.97m$. is as follows: "B B;" the radius vector describing equal distances in equal times on the belt measure of the ellipse, does when projected to the zodiac describe unequal areas in equal times within the zodiac, and describes unequal distances in equal times on the circumference of the zodiac.

This law is as true as it is that we have an earth and sun in space; and it is the proper formula for what Herschel improperly terms "inversely as the distances." We both find the same fact, but Herschel fails to express it in such comprehensive

* NOTE.--Other accelerations are partial duplications of that at perihelion.

words as to show how the increment $1.97m.$ of acceleration is registered on the zodiac. It is not pleasant to be compelled to state that Herschel and others unwittingly propose to subvert this law "B B," by words which have only assumed the form of law by presumption. On the theory that has attained in the sun's motion, that laterally it is quiescent in the focus, no one could account for the whole registered acceleration on the zodiac of the nearly $4m.$ I prove that all the planets surrounding the sun have orbits within themselves respectively, and that on these orbits the eccentric centers of motion are located, and that the centers of motion run round the centers of the planets at each siderial period. One example is hereinafter noted.

At an early period I formulated that the sun moved round an orbit within itself, and illustrated the same in a published work in 1887, by the same illustration that is shown at Figs. 3 and 6. This was formulated on the fact that perfection does not attain in the contours of any of the planets (oblate spheroids) and we can assign no reason why the sun shall be exempt from the analogy; and, on the fact that planets describe ellipses because centrifugal force in some of their parts has a preponderance, and that such preponderance must be equalized on a curve which will result in a constant change of angular velocity. Hence the eccentricity of the orbit has a direct relation to the preponderant centrifugal force in some portion of the planet. It is a self-evident fact that any lateral movement of the sun in the orbit would directly affect recorded acceleration on the zodiac; and as fully half of such acceleration is accounted for by no other means whatever, the sun's motion on its internal orbit must and does make up the wanting increment of acceleration. A calculation has been made on the basis that $57m. 11.5s.$ is to the mean of registered acceleration as

the mean $59m. 8.33s.$ is to $61m. 9.9s.$ This comes out $55,186$ miles as the diameter of the orbit within the sun. The true diameter is a little more than the difference between the points M, N, and the points I, J, Fig. 1. The sun describes the orbit within itself once at each sideral period of the earth.

By this construction, and in the absence of the sun's motion on its small orbit, the distance registers on the zodiac T at A, aphelion, is the same as at I on the zodiac, and as a result acceleration is registered at aphelion of $1.97m.$, where the unit of no acceleration taken is $57m. 11.5s.$, the same as at M N at perhelion. Now, if the drawing, Fig. 1, be turned to the right, we stand at N, and we look along the radii vector V X, the sun will be on its orbit to the right of the focus Z and toward vernal equinox, and precisely such a distance from Z as to cut off from view so much of that increment which the radius vector X has recorded as acceleration at aphelion; this sum is $1.97m.$, and that brings the registration at aphelion back to the unit $57m. 11.5s.$, where observation puts it at that point. Now, as the sun on its small orbit distorts to retard the registration at aphelion it will distort when it is on the opposite portion of its small orbit, toward autumnal equinox, to register on the zodiac acceleration at perhelion. Turn the drawing, Fig. 1, to the left, so the eye sees along the radii vector X V, to N, and the earth moving west on its orbit will be registered as falling short at I on the zodiac more than the increment that it fell short at A, aphelion, and the acceleration found before to be recorded from I to J is more than doubled, and we have then $61m. 9.9s.$ at perhelion, and $57m. 11.5s.$ at aphelion, the mean being $59m. 8.33s.$ The law B B, provides $1.97m$ of registered acceleration; and the motion of the sun on its orbit provides the remainder of the increment, and both equal the total, the nearly $4m.$ of registered acceleration on

the zodiac, while the earth is proven to have moved at all times at a uniform velocity on the belt measure of the ellipse. The 178 days and a fraction on the perihelion side are registered on the zodiac as per acceleration and brought to the equinoxial K, and the more than 186 days are registered as per acceleration on the opposite half of the zodiac from the equinoxial, as they are found by observation.

The calculation of days is made at the time the earth's poles are parallel to the major axis of the orbit. If acceleration registered on the zodiac occurs as though the earth registered on the orbit inversely as the squares of the distances, it is simply a coincidence; as the earth is proven beyond any controversy to have no such movement on the orbit. Inversely as the squares of the distances gives no intimation of the true motion of the earth as projected on the zodiac. It is not "calculus of variation" but legerdemain, which is not tolerated in any other mathematical problem of record. Having found by law B B, almost half of registered acceleration while the earth is moving uniformly on its orbit, the application of inversely as the squares of the distances would make the registered acceleration at perihelion six minutes instead of four. Inasmuch as alleged acceleration falls, its inherent cousin, universal gravity, also falls, and the doors are open for the true school of planet movement.*

THE MOON'S SPIRAL PATH AND ORBIT.

At Fig. 5, A represents so much of the earth's spiral path as is embraced in one synodical period of the moon. C is a plan of the long segment and B a plan of the short segment of the moon's path spirally round the earth's path. The view

NOTE.—The zodiac at the stars is formulated to coincide with a circle whose center is the sun's focus, and one point intersects the orbit at aphelion.

taken is 90° to the earth's path, which lies inclined to the earth's orbit $18^\circ, 30m$. D, D, D, D, D, represents five orbital

positions of the moon, although but one full orbit is the result of the synodical movement. The fifth orbit at the left is a duplicate of the orbit at the right; a represents the position of the earth within the moon's orbit. Lines F and E in nature lie in the same plane, and the angles formed by them respectively, and the path the earth has described in coming to a , at the right of the figure, and the path the earth describes further than a , at the left of the figure, is more than $13\frac{1}{2}^{\circ}$ each, because $13\frac{1}{8}$ sidereal periods of 27° each equal 360° . Then the moon at 2, starts at first quarter more than $13\frac{1}{2}^{\circ}$ from line E and $18^{\circ} 21m. 12s.$ above the path the earth has passed over, and behind the earth half the diameter of the mean of the orbit. From thence on the long segment C to I, opposition, and to 3, third quarter, and has crossed the orbit. From 3 on the short

segment B, the moon is at conjunction at 4, and at 5 the moon comes to the same position as at 2, from whence it started, and it is again behind the earth. Fig. 4 may represent the moon's orbit, and the radii 7, 8, coincide with lines E F, Fig. 5. As the moon starts more than $13\frac{1}{2}^{\circ}$ from line E,

the same is true on the orbit and the moon starts at 5 on the orbit and registers to 6, which is the sidereal portion of the orbit registered by the long segment C. From 6 to 3 the moon registers the synodical portion of the long segment. 3 is third quarter and the short segment registers from it to 5, the starting point. The short segment B only registers from 3 to 5 on the orbit, it being its proportion to the belt of the orbit as the segment B is to C. We always in text books see the four quarters of the moon's orbit represented as at 8, 9, 7, J. This is gross distortion, for as we stand on the earth at *a*, at the right, Fig. V, we see any certain star H, near the moon; and turning the back to the moon at the left of figure 5, a certain star, G, will be in line with the observer and the moon. Now if we stand on the earth I, Fig. 4, and look beyond 8, we do not see the star H, but we will see if we look along the line 5 to 10; again, if the back be turned to the moon at 5, Fig. 4, when we stand on the earth I, we will not be in line with star G, for that star is at 11. Therefore no orbit can be properly represented in four equal 90° , where the path of the primary has a perceptible curve.

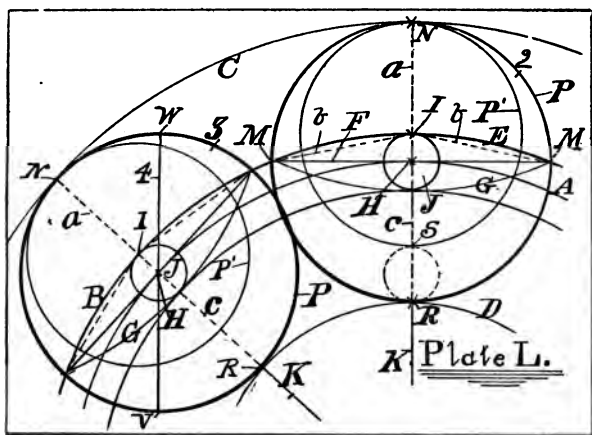
The long and short segments of the moon's path register degrees on the orbit proportional to their lengths. This removes the moon from the apparent witchcraft with which it for all past time has been surrounded.

ALL PLANETS' CENTERS OF MOTION ARE ECCENTRIC.

By a partial examination of the earth's problem at plate L, the following is deduced: C is a segment, which continued circumscribes the earth's exterior path on the mean of its orbit; the segment D likewise circumscribes the interior path.

K K, projected to intersect, gives the sun's position. "In two

concentric circles the exterior circle is so much longer than the interior circle as twice the circumference of an interposed



circle whose diameter equals the distance between the concentric circles." (Euclid.) Then twice the circumference of either circle P, plus the circumference of circle D, equals the circumference of C. Now for the meridians at R of the planet P at the right of the figure to come to the sun as observed, they must travel so much faster than the meridians N as to equal the circumference of the planet P in its one sidereal period thereof, to divide these two circumferences, and equalize the travel of the meridians on the unequal circles C D. If the sun and earth were travelling with equal velocities on parallel lines, the rotation of the earth on its axis would present the meridians uniformly to the sun and stars; but when the sun's direction becomes vertical to the said straight line, and the earth moves round it, the center of motion in the earth becomes eccentric proportionally to the angular velocity the earth has on its orbit. H is the center of the planet and F is the diameter of the planet. If one foot of the dividers be on the sun and the other at M, the segment E will be described

within the planet. I, then will be the center of motion, and J, the small orbit which the center of motion describes at each siderial period of the planet. To obtain the eccentricity of the center of motion in simple form, square the distance the planet is from the sun or primary, square half the diameter of the planet and obtain the square root of these squares, and the difference between the first sum squared and the length of the hypotenuse equals the distance from H to I. The line W V, in the left-hand circle, shows the position the line N R in the right-hand circle would have if the planet turned on the center H; and the line N K, on the circle P at the left, shows the position the same line N K at the right has when the planet turns on the center of motion I. In nature the one movement of the planet round the sun, without a turn on the center of motion, presents all its meridians to the stars, while the same meridian is at all times to the sun, the example being the moon. This is the sideral day more than the solar days. Every turn of the planet thereafter brings the same meridian to the sun, as lines N K passing through the two circles indicate. The lines E G and B G, in both circles, inclose the preponderance of the planet, which lies inside of the eccentric center of motion, and it equals the centrifugal force the planet would have to move on a tangent if the planet turned on the center H. Therefore, if gravity, or any positive force, affected the planet thus balanced by centrifugal and centripetal forces, the universe would be chaos.

SOME LAWS AND EXPRESSED CONDITIONS DEFINING NATURE'S FORCES IN SPACE.

1. In this evolution nature duplicates nothing; neither is a counterfeit possible. Universal diversity is the law which is apparent to every intelligence.

2. Planets are oblate spheroids.

3. Centrifugal and centripetal forces are equal in the oblate spheroid because they produce that contour; then these forces are equal in every section of the planet, and as every section of the planet is an ellipse except the one section through the equator, these forces are equal on the ellipse.

4. (NOTE.) This is hereinbefore proven to be true on the elliptical orbits of planets. Under the law of the oblate spheroid, no matter can leave the planet by the one force, unless brought back by the other.

5. Planets have spiral paths round the moving sun; and satellites have also spiral paths round the paths of their primaries, as they move round the sun.

6. The motion of planets are respectively uniform on their respective spiral paths.

7. (NOTE.) Inasmuch as a screw thread is a spiral path, the law of the screw governs; and, as the screw cannot be operated without the lever, we have in planet movement the application of both of these mechanical powers.

8. Planets have been projected into space by some unknown force; they retain the inertia of the power of projection in a field of non-resistance and have respective uniform velocities.

9. Planets are deflected round their respective central planets by mechanism which does not retard their respective uniform velocities; that is, their centers of motion are changed.

10. Planets' spiral paths increase in inclination to the ecliptic as they recede from the sun, but not in any determined ratio.

11. The center of motion in every planet is outside of the center of the planet; and the preponderance of the planet which lies inside of the center of motion equals, in force, the

force the planet would have to move on a tangent if the center of motion was in the center of the planet.

12. The sun, with every primary, is an electro-magnetic dynamo by which the pole is held substantially parallel to itself; and, as the equator of each planet is inclined to the ecliptic, the action of this force operates on opposite portions of the planet above and below the equator and changes the eccentric center of motion in the planet proportionally to the angular velocity the planet has on the elliptical orbit.

13. (NOTE.) The envelope of an orbit is the peripheries of two orbits, defining one period of the planet, projected to meet; the projections conforming to the curve of the central planet's path, which lies within the envelope; or is the covering of the space circumscribed by the spiral path of the surrounding planet between two orbits.

14. The spiral path of the planet is defined to travel on this envelope, as the thread of a screw passes spirally round a cylindrical body.

15. This envelope twists on its own longitudinal axis precisely like the twisted hand-rail to a geometrical stairway.

16. But as a threaded nut cannot be turned on a body which is an ellipse in cross-section, though a spiral thread be mathematically laid thereon, we have the following law formulated by the author:

17. The mean angular velocity which a planet has on its spiral path round the envelope of an ellipse equals the uniform angular velocity it would have on the true screw path on a cylinder of the same length as the envelope and same belt measure.

18. (EXCEPTION.) When the long and short segments meet on an obtuse angle there is an easing precisely like that on a geometrical stair-rail, under the law that a body in motion

cannot pass over any angle and bear on the track with equal force. Then the spiral is not mathematically full and there will be a variation on the orbit; as is the case with the moon on its orbit.

19. The moon's envelope of orbit twists on its longitudinal axis (like a stair-rail) half of the degrees from siderial to synodical time, on the orbit. See work on the spiral paths of planets, by the author.

20. (NOTE.) This keeps the orbit of the moon in one direction parallel with the ecliptic, as observed.

21. It is found that the inclination of the earth's path round the sun to produce this result is $18^{\circ} 30m$. It may possibly vary a small increment. This being settled, the distance per second the sun travels can readily be determined; as also can the inclination of the spiral path of every other planet.

22. The sun's direct motion is little more than six miles per second.

23. The cause, by which acceleration is recorded on the zodiac, is as follows:

24. BB. When the planet is running even distances in even times on the belt measure of the ellipse, the radius vector projected to the zodiac describes unequal areas in equal times within the zodiac, and describes unequal distances in even times on the periphery of the zodiac. This accounts for nearly half of the registered acceleration.

25. The remainder of acceleration is accounted for by the motion of the sun on a small orbit within itself of 55,186 miles.

26. Every day, after maximum acceleration, duplicates less and less of that maximum till aphelion is reached.

THE GRAND EPOCHS IN THE ASTRONOMICAL AGES ARE:

1. The zodiac formulated by the unknown.
2. The earth has its orbit round the sun, moves from west to east and rotates on itself once in one mean day of twenty-four hours. (Pythagoras.)
3. The orbits of planets are ellipses, and the squares of their periods differ as the cubes of their distances. (Kepler.)
4. The formulation of planet movement on the Pythagoras system by (Copernicus.)
5. The sun proven to have a direct motion in space. (Struve & Maadler.)
6. The entire system of astronomy based on the spiral paths of planets round a moving sun, involving the whole mechanism of the solar system. (Chapin.)

CONCLUSION.

The author in the foregoing has not deceived himself; and he is pleased to hand these facts down to posterity as laws, deductions and formulations which will withstand scrutiny so long as planets have paths in space. After searching out the heavens for half the allotted time of man, he takes no little pride in having thrown the windows of heaven wide open to show how the sun and earth move to form the great time register for man; and to prove beyond any doubt and establish that the sun has an orbit within itself. This work forms but a minor portion of his published works. And taking the whole, there is furnished sufficient data for one hundred future years of sound scholarly labor. All has been done without undue regard or disregard for the labors of distinguished gen-

tlemen. They are simply proven to be in error without any personal fault. That the author has established these facts is not to their discredit, and all ought to find relief in the fact that these knotty problems are, after all the ages, truthfully disposed of. Anticipating an interrogation, it is stated that through all past time there has come on the stage of life the many individuals who respectively knew more about certain matters than all the world beside. Were not this true, present civilization could not have attained. All the opinions which gentlemen may hold as to this work have been already discounted.

Kepler possessed one of the best minds that ever contemplated planet movement, and that he erred in formulating that "the radius vector describes equal areas within the orbit" at that remote period cannot detract from the honor his due, especially when the error has not been detected by the great army of distinguished scholars following him, and then detected only by the author by the law "B B," and the discovered sun's motion on its internal orbit. It can only truthfully be said of the Newtonian system, that it is a misconception of the powers and mechanics in nature; it presumes coercive power vested in planets, and also the power of one planet to affect the life—that is, the motion of another planet. If the Newtonian system could but attain for one second, eternal chaos would result. Nature cunningly avoids coercion by changing the centers of motion in planets proportionally to the angular velocity the planet has on its orbit.

But a few years will elapse till the general intelligence will wonder at the age of darkness in which coercion was formulated as a factor in elementary planet movement.

GEORGE LEANDER CHAPIN.

CHICAGO, ILL., June, 1894.

ADDENDUM.

THE SUN'S TRUE AND APPARENT MOTION IN SPACE, AND THE EARTH'S RELATIVE MOTION.

The sun's prime motion is on a spiral path which registers an orbit of such magnitude that an arc described by the sun's one year travel differs so little from a straight line that the versed sine of half the angle is not even suggested. The earth travels about 606,000,000 miles while the sun travels about 193,000,000 miles, and the earth travels about 31,000,000 miles more on its spiral path than its orbital registration. We stand at perihelion and see the sun register on the zodiac at aphelion, and *vice versa*. If we ride on the earth from perihelion 57m. 11.5s., the sun will have registered from aphelion 59m. 8.33s. The excess more than 57m. 11.5s. at perihelion is due to the greater distance from the sun to aphelion than to perihelion on the orbit. Now if we try to apply Kepler's equal areas, and continue to ride on the earth to a point 61m. 9.9s. from perihelion, we will see that the sun has registered 6m. from aphelion. Therefore, the more we try to register the earth on its orbit inversely as the squares of the distances, the more the sun records against us at aphelion, for the reason given. If we ride on the earth from aphelion 57m. 11.5s., the sun will register the same on the zodiac at perihelion, because the sun is at the center of the two points. But if we could stand on the sun and see the earth register 57m. 11.5s. on the orbit at perihelion, it at the same time would register 59m. 8.33s. on the zodiac—presuming in all these observations the center of the sun to be fixed in the focus.

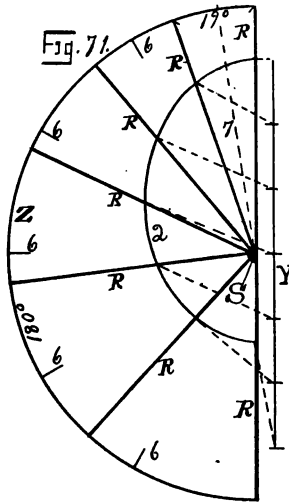
These facts and deductions are very simple, and come within the intelligence of the ordinary mind, and in future ages they will not be disturbed. John Herschel, in *Outlines of Astronomy*, states emphatically with reference to the movement of the radius vector on the orbit, as per Kepler, "that there are no means of demonstrating it."

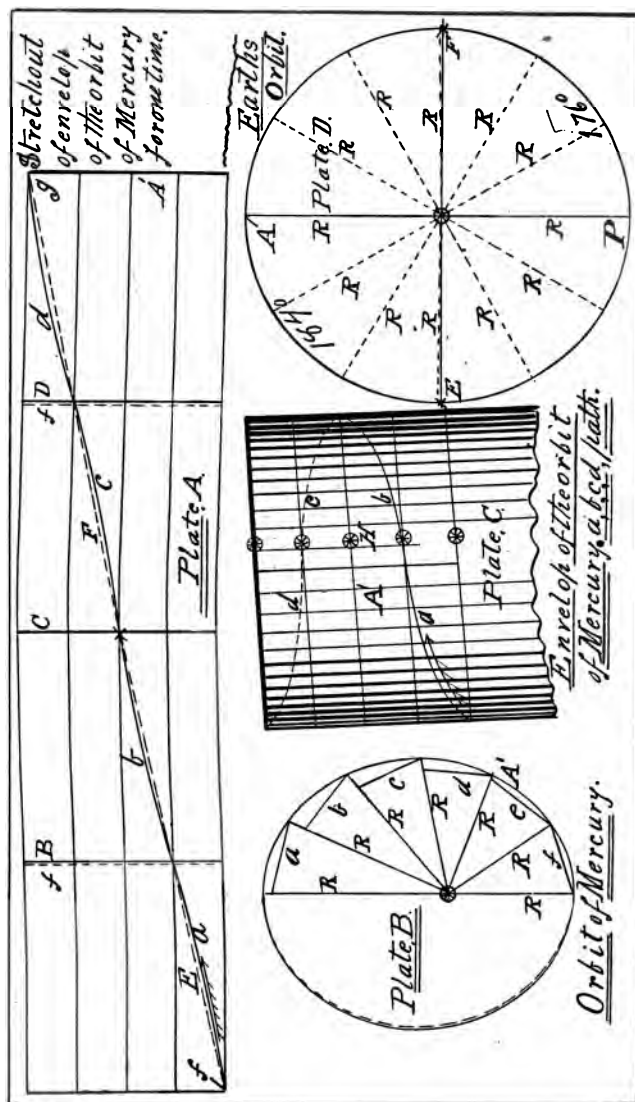
It is proper to inquire when the sun's motion on its internal orbit is one of the prime factors of acceleration, how will the words "inversely as the squares of the distances" accelerate? It is clearly shown and proven that the motion of the sun on its internal orbit produces more than half of the 4m. acceleration on the zodiac at perihelion, retards that acceleration to aphelion, and accelerates on the zodiac the sun's registration back to perihelion. This is precisely the problem and the solution thereof, and no scholar can set forth any causes for the sun's apparent acceleration except those herein set forth. The mechanical field has been exhausted in the production of facts.

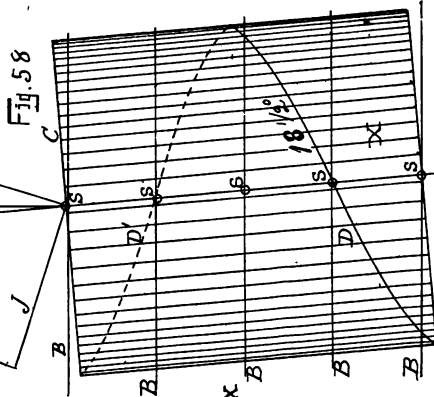
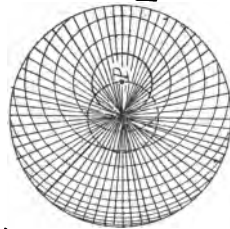
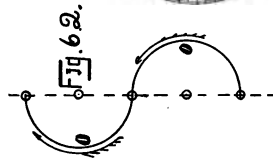
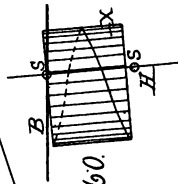
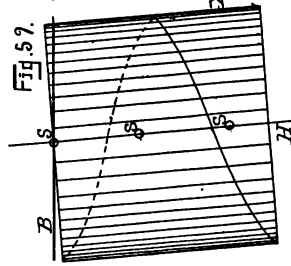
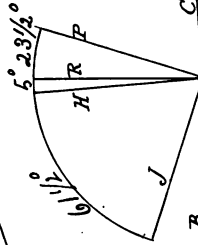
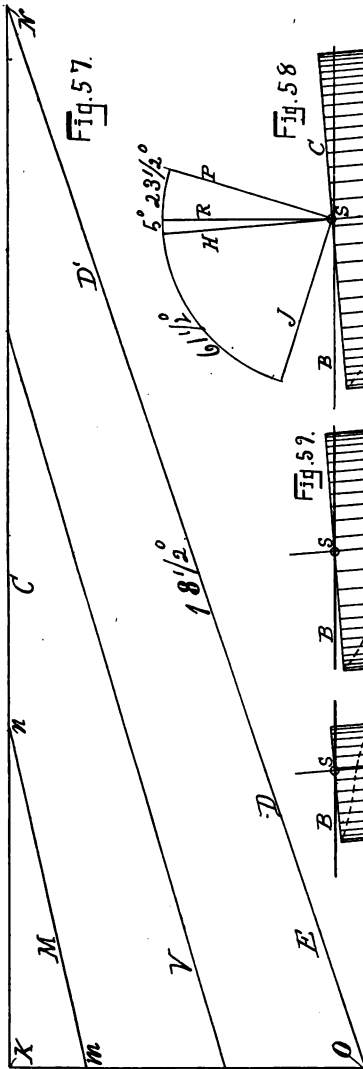
27. All planets in the solar system have respectively three distinct and well-defined motions: A direct motion on its spiral path; a motion round an orbit within itself; and a rotation on an eccentric center of motion also within the planet.

28. The densities of planets differ as the respective sums of inclinations of their spiral paths, the velocities of planets thereon and diameters differ.

Pages 19, 20 and 21 contain illustrations in the work of 1891. Fig. 71, page 19, is a graphic proof of law "BB." On page 20 is illustrated the spiral path, the orbit and envelope of the orbit of Mercury. On page 21 is illustrated the spiral path of Mercury, Venus and the earth. Line H is the sun's path 90° to the earth's orbit C; B is the ecliptic; N to O is the earth's travel for one year, and O to K is the sun's travel for the same period.



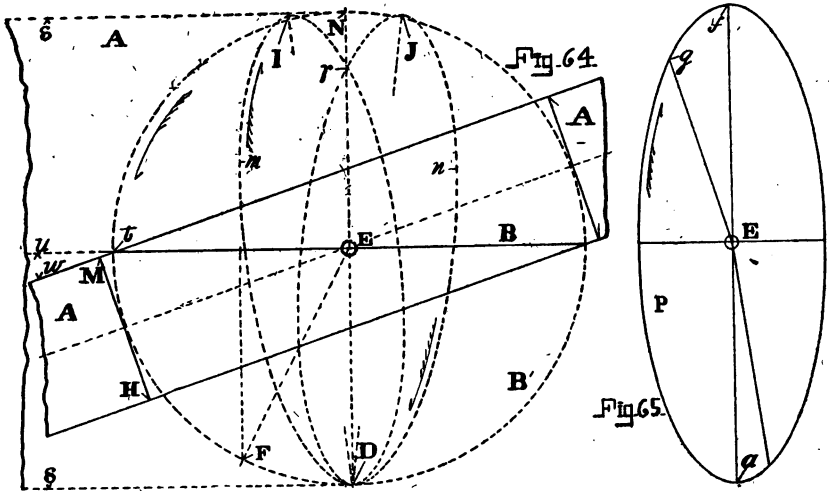




PROOF BEYOND REFUTATION.

It is a well-settled principle in mathematics that the mean of a uniform differential increase or decrease is at the center of the line-containing the construction. Therefore it is self-evident that if we conjecture that the earth on its orbit registers 4*m*. at perihelion and 0 at aphelion, the mean of acceleration will be at the intersection of the minor axis with the orbit. But by observation on the zodiac, where the registration is made, this is found not to be true, for the mean is at the equinoxial and at the distance of the eccentricity from the minor axis. Then the acceleration is wholly on the zodiac, because the mean of acceleration is at the intersection of the diameter of the great circle. It is therefore evident to the unprejudiced scholar that the theory that the radius vector registers on the orbit inversely as the squares of the distances has no foundation in fact, and is disproved by graphic diagrams, mechanics and established mathematics. With due regard to the valuable labors of distinguished gentlemen, it must be recorded that heretofore no sagacious mind has been directed to the proper elements forming a correct problem. The fact that the mean of acceleration on the zodiac is over 1,500,000 miles toward perihelion from the minor axis of the orbit is the wedge which rends wide open the whole alleged Newtonian system. Therefore, all that has been published about acceleration of the earth and its orbit and universal gravity is only valuable in the waste-basket of the press-room.

G. L. C.



PROBLEM OF THE SUN, EARTH AND MOON.

A screw thread runs half round and changes direction; therefore if the Earth's inclined path is correctly given the twist of the Moon's envelope of orbit for one synodical period will twist on its long axis half of the degrees registered by the Moon from the sidereal to synodical time on the orbit. The twist, therefore, will be then about 134 degrees for that period. Fig. 64 is compound; the full lines is an elevation of a portion of the envelope of orbit, inclined 18 degrees, 30 minutes to the Earth's spiral path; as shown by the angle u, w, t ; and 5 degrees, 8 minutes, 48 seconds to the ecliptic. Dotted line S, S' is a plan of the orbit and a portion of said envelope; m is an ellipse whose major axis extends from S to S' , and its minor axis from M to H . D, F , represents the arc, about 27 degrees, which the Moon describes from sidereal to synodical time, and the angle D, I, J , is half of the angle D, E, F . The stand point is at conjunction looking toward opposition N . Divide the belt of the cardboard ellipse m , in any suitable number of spaces by marks, and divide the arc I, J , by like number of spaces; pivot the ellipse at D and swing it one space between I, J , and mark the first space of m , on a surface within the orbit B' ; continue till all the spaces are marked and while I reaches J , the pencil will have circumscribed from D round to D , but the ellipse P , not m , will be traced; that is, if the figure traced be severed on its major axis and the sections be reversed the ellipse P will be the result. Now if the belt of the arc I, J , Fig. 64 be laid on Fig. 65, from f , to g ; f, g , will be to the remainder of the belt of ellipse P , as the arc D, F , is to the remainder of the orbit B' . When this is so brought out we have the proof that the Earth's path has the correct inclination to its orbit. The twist of the Moon's envelope of orbit on its long axis for one sidereal period of the Earth's path, is very nearly 164 degrees, the Earth's path being inclined to its orbit 18 degrees 30 minutes. If the said envelope did not twist like a screw thread no comprehensible orbit could exist.

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